MEASURING THE SPATIAL WIGNER FUNCTION AT A SINGLE PHOTON LEVEL

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Abstract

The Wigner function completely characterizes the state of a photon. Normally one can only measure the probability distribution of the Schrodinger Wave Function but the complete wave function can be extracted from the Wigner Function. In this experiment a Sagnac (Ring or Closed Loop) Interferometer was used to measure the spatial Wigner function. A detector was put at the interference pattern produced by the interferometer. A scanning mirror was the key to graphing the Wigner function. It was able to both shear (translate) in the x direction and tilt (rotate) in the kx direction. Thus, measuring the intensity at each (x,kx) point revealed the Wigner Function evaluated at that point. Two types of detectors were used in the experiment to measure the intensity of the interference pattern. First, a photo-diode was used. Then a photo-multiplier tube was used, so that single photon states could be measured. The laser beam was attenuated down to the order of one-hundred thousand photons a second and a photon per second measurement was used to gather intensity data. This was the first time single photon states have been measured. To test the interferometer's capabilities very precise single and double slits were constructed. The results these apparatus produced for both the photo-diode and photo multiplier tube are very close to the theory.

Category

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